



# COMMON PRE-BOARD EXAMINATION

## MATHEMATICS-Code No. 041

### Class-XII-(2025-26)

**SET: 3**



**Time allowed: 3 Hrs.**

**Maximum Marks: 80**

#### General Instructions:

Read the following instructions carefully and strictly follow them:

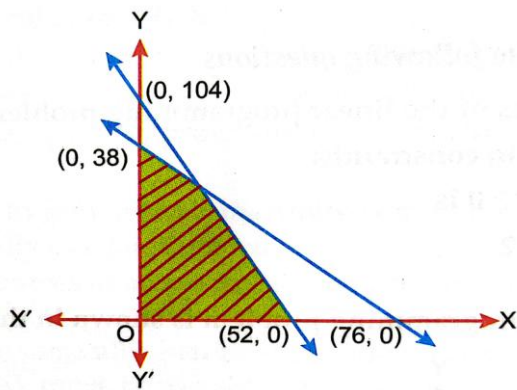
- This question paper contains **38** questions. **All** questions are **compulsory**.
- This question paper is divided into **five** sections – **A, B, C, D** and **E**.
- In **Section A**, Questions **1** to **18** are multiple choice questions (MCQs) with only one correct option and questions **19** and **20** are Assertion-Reason based questions of **1** mark each.
- In **Section B**, Questions **21** to **25** are very short answer (VSA) type questions, carrying **2** marks each.
- In **Section C**, Questions **26** to **31** are short answer (SA) type questions, carrying **3** marks each.
- In **Section D**, Questions **32** to **35** are long answer (LA) type questions, carrying **5** marks each.
- In **Section E**, Questions **36** to **38** are case based questions, carrying **4** marks each.
- There is no overall choice. However, an internal choice has been provided in 2 questions in Section B, 3 questions in Section C, 2 questions in Section D and one subpart each in 2 questions of Section E.
- Use of calculator is **not** allowed.

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Q. No.	Questions	Marks
	<b>SECTION A</b>	
	<b>This section comprises of multiple-choice questions (MCQs) of 1 mark each.</b>	
	<b>Select the correct option (Question 1 - Question 18)</b>	
1.	The domain of the function $\cos^{-1}(2x - 1)$ is (a) $[0, 1]$ (b) $[-1, 1]$ (c) $(-1, 1)$ (d) $[0, \pi]$	1
2.	If A is matrix of order $m \times n$ and B is a matrix such that $AB'$ and $B'A$ are both defined, the order of matrix B is (a) $m \times m$ (b) $n \times n$ (c) $n \times m$ (d) $m \times n$	1
3.	If A is a square matrix of order $3 \times 3$ such that $ A  = 2$ , then the value of $ adj(adjA) $ is (a) -16                              (b) 16                              (c) 0                              (d) 2	1

4. If  $\begin{bmatrix} 2 & 0 \\ 5 & 4 \end{bmatrix} = P + Q$ , where  $P$  is symmetric and  $Q$  is skew symmetric matrix, then  $Q$  is equal to 1
- (a)  $\begin{bmatrix} 2 & \frac{5}{2} \\ \frac{5}{2} & 4 \end{bmatrix}$       (b)  $\begin{bmatrix} 0 & -\frac{5}{2} \\ \frac{5}{2} & 0 \end{bmatrix}$       (c)  $\begin{bmatrix} 0 & \frac{5}{2} \\ -\frac{5}{2} & 0 \end{bmatrix}$       (d)  $\begin{bmatrix} 2 & -\frac{5}{2} \\ \frac{5}{2} & 4 \end{bmatrix}$
5. If the sum of all the elements of a  $3 \times 3$  scalar matrix is 9, then the product of all its elements is 1
- (a) 0      (b) 9      (c) 27      (d) 729
6. Value of the determinant  $\begin{vmatrix} \cos 15^\circ & \sin 15^\circ \\ \sin 15^\circ & \cos 15^\circ \end{vmatrix}$  is 1
- (a) 0      (b)  $\frac{\sqrt{3}}{2}$       (c)  $\frac{1}{2}$       (d) 1
7. If  $y = \tan^{-1} x$  then the value of  $(1 + x^2)y_2$  is equal to 1
- (a)  $xy_1$       (b)  $-xy_1$       (c)  $2xy_1$       (d)  $-2xy_1$
8. The value of  $k$  for which function  $f(x) = \begin{cases} x^2, & x \geq 0 \\ kx, & x < 0 \end{cases}$  is differentiable at  $x = 0$  1
- (a) 0      (b) 1      (c) 2      (d) any real number
9. The bottom of a rectangular swimming tank is 25m by 40m water is pumped into the tank at the rate of 500 cubic meters per minute. The rate at which the level of water in the tank is rising is 1
- (a)  $\frac{1}{4}$  m/min      (b)  $\frac{2}{3}$  m/min      (c)  $\frac{1}{3}$  m/min      (d)  $\frac{1}{2}$  m/min
10.  $\int \frac{2^{\frac{1}{x}}}{x^2} dx = k2^{\frac{1}{x}} + C$ , then  $k$  is 1
- (a)  $\frac{-1}{\log 2}$       (b)  $\frac{1}{\log 2}$       (c)  $\frac{1}{2}$       (d)  $\frac{-1}{2}$
11.  $\int \frac{10x^9 + 10^x \log_e 10}{x^{10} + 10^x} dx$  equals 1
- (a)  $10^x - x^{10} + C$       (b)  $10^x + x^{10} + C$   
(c)  $(10^x - x^{10})^{-1} + C$       (d)  $\log(10^x + x^{10}) + C$
12. The general solution of the differential equation  $\frac{dy}{dx} = e^{x+y}$  is 1
- (a)  $e^x + e^{-y} = C$       (b)  $e^x + e^y = C$       (c)  $e^{-x} + e^y = C$       (d)  $e^{-x} + e^{-y} = C$
13. The respective values of magnitudes of  $\vec{a}$  and  $\vec{b}$ , if given  $(\vec{a} - \vec{b}) \cdot (\vec{a} + \vec{b}) = 512$  and  $\vec{a} = 3\vec{b}$ , are: 1
- (a) 48 and 16      (b) 3 and 1      (c) 24 and 8      (d) 6 and 2

14. If  $\vec{a} = \hat{i} + \hat{j} - \hat{k}$ ,  $\vec{b} = -\hat{i} + 2\hat{j} + 2\hat{k}$  and  $\vec{c} = -\hat{i} + 2\hat{j} - \hat{k}$  then a unit vector normal to the vectors  $(\vec{a} + \vec{b})$  and  $(\vec{b} - \vec{c})$  is 1  
 (a)  $\hat{i}$  (b)  $\hat{j}$  (c)  $\hat{k}$  (d)  $\hat{a}$
15. If a line makes angles  $\alpha, \beta$  and  $\gamma$  with the axes respectively, then  $\cos 2\alpha + \cos 2\beta + \cos 2\gamma =$  1  
 (a) -2 (b) -1 (c) 1 (d) 2
16. In an LPP, if the objective function  $Z = ax + by$  has the same maximum value at two corner points of the feasible region, then the number of points at which  $Z_{max}$  occurs is 1  
 (a) 0 (b) 2 (c) finite (d) infinite
17. The feasible region of a linear programming problem is shown in the figure below: 1  
 Then, the constraints of the LPP are  $x \geq 0, y \geq 0$  and



- (a)  $2x + y \leq 52$  and  $x + 2y \leq 76$  (b)  $2x + y \leq 104$  and  $x + 2y \leq 76$   
 (c)  $x + 2y \leq 104$  and  $2x + y \leq 76$  (d)  $x + 2y \leq 104$  and  $2x + y \leq 38$
18. For any two events A and B, if  $P(\bar{A}) = \frac{1}{2}$ ,  $P(\bar{B}) = \frac{2}{3}$  and  $P(A \cap B) = \frac{1}{4}$ , then  $P\left(\frac{\bar{A}}{\bar{B}}\right)$  is 1  
 (a)  $\frac{3}{8}$  (b)  $\frac{8}{9}$  (c)  $\frac{5}{8}$  (d)  $\frac{1}{4}$

### ASSERTION-REASON BASED QUESTIONS

**(Question numbers 19 and 20 are Assertion-Reason based question carrying 1 mark each. Two statements are given, one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer from the options (a), (b), (c) and (d) as given below.)**

- (a) Both (A) and (R) are true and (R) is the correct explanation of (A).  
 (b) Both (A) and (R) are true but (R) is not the correct explanation of (A).  
 (c) (A) is true, but (R) is false.  
 (d) (A) is false, but (R) is true.
19. **Assertion (A):** Principal value of  $\tan^{-1}(-\sqrt{3})$  is  $-\frac{\pi}{3}$ . 1  
**Reason (R):**  $\tan^{-1} x : \mathbb{R} \rightarrow \left(\frac{-\pi}{2}, \frac{\pi}{2}\right)$  so for any  $x \in \mathbb{R}$ ,  $\tan^{-1}(x)$  represents an angle in  $\left(\frac{-\pi}{2}, \frac{\pi}{2}\right)$

20. **Assertion (A):** Vector equation of the line passing through the points (1, 2, 3) and (5, -4, -7) is  $\vec{r} = (\hat{i} + 2\hat{j} + 3\hat{k}) + \lambda(5\hat{i} - 4\hat{j} - 7\hat{k})$  where  $\lambda$  is a parameter. 1  
**Reason (R):** Vector equation of straight line passing through two given points with position vector  $\vec{a}$  and  $\vec{b}$  is  $\vec{r} = \vec{a} + \lambda(\vec{b} - \vec{a})$

### SECTION B

**This section comprises of 5 very short answer type questions (VSA) of 2 marks each.**

21. a) Find the value of: 2  
 $\sin \left[ \tan^{-1}(-\sqrt{3}) + \cos^{-1}\left(-\frac{\sqrt{3}}{2}\right) \right]$

**OR**

- b) Find the value of  $\sin^{-1} \left[ \sin \left( -\frac{17\pi}{8} \right) \right]$

22. If  $x = e^{\frac{x}{y}}$ , then find  $\frac{dy}{dx}$ . 2

23. If  $x^{30}y^{20} = (x + y)^{50}$ , prove that  $\frac{dy}{dx} = \frac{y}{x}$ . 2

24. a) Find:  $\int \frac{(x-3)}{(x-1)^3} e^x dx$  2

**OR**

- b) Evaluate:  $\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \frac{dx}{1 + \sqrt{\tan x}}$

25. Find the direction cosines of the line whose Cartesian equation is: 2  
 $5x - 3 = 15y + 7 = 3 - 10z$

### SECTION C

**This section comprises of 6 short answer type questions (SA) of 3 marks each.**

26. a) If  $y\sqrt{1-x^2} + x\sqrt{1-y^2} = 1$ , then prove that  $\frac{dy}{dx} = -\sqrt{\frac{1-y^2}{1-x^2}}$  3

**OR**

- b) If  $x^y = e^{x-y}$ , prove that  $\frac{dy}{dx} = \frac{\log x}{(\log(xe))^2}$  and hence find its value at  $x = e$ .

27. i) If  $f(x) = x + \frac{1}{x}$ ,  $x \geq 1$ , show that  $f$  is an increasing function. 3  
 ii) Find the maximum profit that a company can make, if the profit function is given by,  $p(x) = 41 - 72x - 18x^2$

28. a) Sketch the graph  $y = |x + 3|$ . Evaluate  $\int_{-6}^0 |x + 3| dx$ . 3

**OR**

- b) Find the area of the region bounded by the parabola  $y^2 = 2x$  and the line  $x - y = 4$ .

29. a) A line passes through  $(2, -1, 3)$  and is perpendicular to the lines  $\vec{r} = \hat{i} + \hat{j} - \hat{k} + \lambda(2\hat{i} - 3\hat{j} + \hat{k})$  and  $\vec{r} = 2\hat{i} - \hat{j} - 3\hat{k} + \mu(\hat{i} + 2\hat{j} + 2\hat{k})$ . Obtain its equation in vector and cartesian form. 3

**OR**

- b) Given that  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  form a triangle such that  $\vec{a} = \vec{b} + \vec{c}$ . Find p, q, r, s such that area of triangle is  $5\sqrt{6}$  where  $\vec{a} = p\hat{i} + q\hat{j} + r\hat{k}$ ,  $\vec{b} = s\hat{i} + 3\hat{j} + 4\hat{k}$  and  $\vec{c} = 3\hat{i} + \hat{j} - 2\hat{k}$
30. Minimize:  $Z = x - 5y$  3  
 Subject to constraints:  $x - y \geq 0$ ,  $-x + 2y \geq 2$ ,  $x \geq 3$ ,  $y \leq 4$ ,  $y \geq 0$
31. In a hostel, 60% of the students read Hindi newspaper, 40% read English newspaper and 20% read both Hindi and English newspapers. A student is selected at random. 3
- i) Find the probability that he/she reads neither Hindi nor English newspapers.
- ii) If she reads Hindi newspaper, find the probability that she reads English newspaper.

### SECTION D

**This section comprises of 4 long answer type questions (LA) of 5 marks each.**

32. If  $A = \begin{bmatrix} 1 & 2 & 0 \\ -2 & -1 & -2 \\ 0 & -1 & 1 \end{bmatrix}$ , find  $(A)^{-1}$ . 5  
 Hence, solve the system of linear equations:  
 $x - 2y = 10$   
 $2x - y - z = 8$   
 $-2y + z = 7$

33. a) Integrate:  $\frac{(x^2+1)(x^2+2)}{(x^2+3)(x^2+4)}$  5

**OR**

- b) Evaluate:  $\int_0^1 \frac{\log(1+x)}{1+x^2} dx$
34. a) Solve the differential equation: 5  
 $(x^2 - 1) \frac{dy}{dx} + 2xy = \frac{2}{x^2-1}$ , where  $x \in (-\infty, -1) \cup (1, \infty)$

**OR**

- b) Find the particular solution satisfying the given condition:  
 $2xy + y^2 - 2x^2 \frac{dy}{dx} = 0$ ;  $y = 2$  when  $x = 1$
35. Find the coordinates of the foot of perpendicular and the length of the perpendicular drawn from the point P  $(5, 4, 2)$  to the line  $\vec{r} = -\hat{i} + 3\hat{j} + \hat{k} + \lambda(2\hat{i} + 3\hat{j} - \hat{k})$ . Also find the image of P in this line. 5

## SECTION E

This section comprises of 3 case-study/passage-based questions of 4 marks each with subparts. The first two case study questions have three subparts (i), (ii), (iii) of marks 1, 1, 2 respectively. The third case study question has two subparts of 2 marks each.

### 36. Case Study -1

A city's traffic management department is planning to optimize traffic flow by analyzing the connectivity between various traffic signals. The city has five major spots labelled *A*, *B*, *C*, *D* and *E*.



The department has collected the following data regarding one-way traffic flow between spots:

1. Traffic flows from *A* to *B*, *A* to *C* and *A* to *D*.
2. Traffic flows from *B* to *C* and *B* to *E*.
3. Traffic flows from *C* to *E*.
4. Traffic flows from *D* to *E* and *D* to *C*.

The department wants to represent and analyze this data using relations and functions.

Use the given data to answer the following questions:

- i) Is the traffic flow reflexive? Justify. 1
- ii) Is the traffic flow transitive? Justify. 1
- iii) a) Represent the relation describing the traffic flow as a set of ordered pairs. Also state the domain and range of the relation. 2

**OR**

- iii) b) Does the traffic flow represent a function? Justify your answer.

37. **Case Study II:**

Read the following passage and answer the following questions.

Engine displacement is the measure of the cylinder volume swept by all the pistons of a piston engine. The piston moves inside the cylinder bore.

The cylinder bore in the form of circular cylinder open at the top is to be made from a metal sheet of area  $75\pi \text{ cm}^2$



- i) If the radius of cylinder is  $r$  cm and height is  $h$  cm, then write the volume  $V$  of cylinder in terms of radius  $r$ . 1
- ii) Find the rate of change of  $V$  with respect to  $r$ . 1
- iii) a) Find the radius of cylinder when its volume is maximum 2

**OR**

- iii) b) For maximum volume, check if  $h > r$ .

38. **Case Study III:**

There are two shops in a market A and B. In A there are 30 tin pure Mustard oil, 40 tin adulterated mustard oil, while in B there are 50 tin pure Mustard oil and 60 tin adulterated oil. Babu wants to purchase one tin oil from any shop selecting at random.

- i) Find the total probability of purchasing adulterated mustard oil if shop and tin of oil are selected at random. 2
- ii) Babu wants to know quality of mustard oil. Before purchasing he selected first a shop at random and then selected a tin of mustard oil at random. If the tin selected at random has adulterated oil, then find the probability that the selected tin is from shop A. 2